



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 1, January 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

**Impact Factor: 7.512**

9940 572 462

6381 907 438

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# Review on Backhoe Assembly of JCB3DX Model

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**ABSTRACT:**Excavators of JCB's are used for various earth moving purposes. Actual earth moving in them is done by backhoe assembly. In this backhoe assembly, the dipper stick is the part which connects the boom with the bucket. The stick provides the digging movement needed to pull the bucket through the ground. There are some problems like dipper stick can't getting closer to the machine when they're trenching, questions on their structural rigidity as it fails sometime, lifting capacities problems with the weight of the bucket, load and stick can be eliminated. Because of such problems the drivers have to reposition the machine more times. So, they can be made more productive by improving their design. During some earth moving conditions, multiple design factors of dipper stick have the chance of redesigning them to get them modified and more reliable. The next important part is the H link which connects between the dipper stick and bucket. The degrees of freedoms where restricted to some movements because of this H link. Its design plays important role in actuating the bucket digging so it is important. The next part of chain of backhoe assembly is bucket. Its capacity, design, material and failures are crucial because it makes the direct contact with load. One of the parameters affecting the productivity of machine is bucket tooth. A poor design of teeth results in poor excavation and ultimately reduces its efficiency. For maximum digging force condition the evaluated digging force can be used as boundary condition and loading condition to carry out analysis of excavator bucket tooth. This paper is for making design modifications to the dipper stick, H link, Bucket and Bucket Teeth.

**KEYWORDS:** Backhoe, JCB3DX, Bucket, H link, Dipper stick, Bucket teeth.

## I. INTRODUCTION

The backhoe of the JCB is the main tool of the backhoe loader. It's used to dig up hard, compact material, usually earth, or to lift heavy loads. It can lift this material and drop it where it is required. The backhoe is a big, extremely powerful version of JCB.

Following are some of the contributors of researchers in the area of analysis of effect of different parameters (materials, construction). There are four section i.e. Dipper stick, H link, Bucket and bucket teeth. There analysis of one by one paper are done as follows

## II. RELATED WORK

### 1. DIPPER STICK

Dipper stick for excavator of high strength polymeric composite materials and method for manufacturing such by [Jae I. Ko](#), [Jae W. Lee](#), [Yoon M. Lee](#), [En J. Jean](#), [Chun K. Kim](#), [Jin Kim](#). Their paper addresses to invention which

provides weight reduction of about 50%-60% in comparison with a conventional structural steel dipper stick and also about 6.8%-13.9% in comparison with the conventional structural steel dipper stick on the basis of weight ratio of excavated earth.

Excavator basket-stick connection by [Robert A Montgomery Donald J Greer](#). They addresses towards an excavator basket-stick connection utilizing a quick changing, removable connection adapter so that excavator baskets, i.e., back hoes, buckets, rippers, etc. can be interchangeably mounted on the same or different swinging members, viz., dipper sticks and the like. The adapting device includes a generally elongated U-shaped frame adapted to hopefully engage the upper free edge of the basket and opposite this engagement to enter into wedge bearing with the basket rear outer wall; the adapter frame being equipped with a plurality of pin receiving openings for connection to the dipper stick and the mounting lugs on the basket outer rear wall.

Boom and dipper stick construction [Allan J. Albrecht Richard C. Van Ooyen](#). They addresses towards a boom and dipper stick construction for mobile excavators and an improved method of manufacturing the same. The boom and dipper stick are fabricated from side plates that are butt welded together with respect to various hinge point locations to eliminate the necessity of doublers plates on the sides of the structures. The butt welds are located at non-critical areas to provide for even stress flow and ease of manufacture. A method of welding together the side plates of the boom and dipper stick construction in an end to end abutting relationship in a manner which attains a complete weld penetration over the entire length of the joint.

#### Methodology:

##### 1. Analysis of Dipper stick:

We will select dipper stick of specific JCB model. Then we will first analyse the design considerations of it like dimensions, failures, manufacturing methods etc.

##### 2. Design of length of dipper stick:

The dipstick is connected from the pivot of boom to the bucket that scoops the earth. It serves as the fore-arm of the backhoe. The design for the length of the dipper stick can eliminate problems of trenching. What the users of JCB excavators are facing with repositioning of machining problem can be removed from this.

##### 3. Modes of failure:

By suggesting modifications to the manufacturing or designing materials of dipper stick can decrease the chances of their failures by increasing their strength and reliability.

##### 4. Forces calculations during lifting and digging:

By designing for higher breakout forces, means more digging and lifting capability or for same conditions with more reliable design of digging and lifting capabilities can be done.

## 2. H Link

Analysis of structural optimization of excavator bucket link by RiteshSarode, S. S. Sarawade. Their paper address to the optimization of bucket link of heavy duty hydraulic excavators.

At the time of excavation process there are various unknown resistive forces acting on the bucket and bucket teeth's and this forces are transferred to the various parts of excavators. So the excavators link is one this the where these unknown forces are acted. Excavator links plays very important role at time of digging and excavating. So for this part we should provide good design as well as giving maximum reliability, minimum weight, and cost.

According to papers the 3d model of link is prepared with the help of CATIA V5 then the meshing is carried out by hyper mesh, for meshing tetra hedral mesh is preferred. For preprocessing, solution post processing ANSYS is used. With the help of results topology optimization will be carried out. By using software Optistruct it is determined that where the stress concentration is less. After all of these process bucket link will be manufactured and heat treatments will be carried out for improving its mechanical properties, strength, load carrying capacity then testing will be done using UTM to validate the results.

The future scope for optimization for further research work is done by removing material from the low stressed regions and re-designing the bucket link.

Methodology:

1) Making of CATIA model:

First of all by measuring the actual dimension of the link we have to make a CATIA model of same. This CATIA model helps us in the further analysis.

2) Meshing:

Cad model is to be generated in part design module of CATIA V5. These parametric generation of drawings will help to get the dimensions which are useful in forces calculations in static loading conditions. In this stage .igs file is imported to the meshing software like hyper mesh. The CAD data of the bucket link structure is to be imported and the surfaces were created and meshed. Since all the dimensions of bucket link are measurable (3D), the best element for meshing is the tetra-hedral.

3) Boundary conditions:

After meshing is completed boundary conditions are applied. These boundary conditions are the reference points for calculating the results of analysis. Here the different load steps are created which to be applied during the analysis. Elements are defined by their material properties such as density, modulus of elasticity, poisson's ratio etc. is assigned to the elements. The proper arrangements is to be made so the analysis can run in solver software. After the completion of process model is exported to the solver.

4) Analysis:

In this step Meshed and boundary condition applied model is imported to the solver. Software first calculates the deflection with respect to the boundary conditions applied. Then on the basis of deflection it the strain is calculated. Once the strain is calculated the modulus of elasticity is known then the stress values are calculated.

### 3. Bucket

In this paper Mr. Swapnil S. Nishane, Dr. S.C. Kongre, Prof. K.A. Pakhare , they have done the analysis of bucket by considering the existing model of bucket and gives the optimized solution for the excavator bucket. Bucket are consisting the several stresses due to which the life of their parts are decreased. By doing certain analysis on existing model they obtained a optimized solution.

Methodology:

1. First the dimension of existing excavator bucket are taken by using reverse engineering process ,this is done by using vernier caliper, steel rule, screw gauge.

2. Preparation of CAD model:

By using dimension the 3d CAD model is prepared in the software. Then this CAD model is converted in to neutral format for FEA analysis ,because directly CAD file cannot be used for analysis in FEA software. And this file is converted in to The Initial Graphics Exchange Specification (IGES).

3. Structural analysis of existing backhoe excavator bucket using ansys:

In this analysis found out the effect of forces applied on the bucket structure through the digging force applied on to bucket. Also find out deformation, various stresses induced and the life cycle of bucket. and then the structure is tested for different stress analysis such as shear stress, normal stress, life cycle and total deformation etc. And the result is obtained in table format and found that total deformation is 2.677mm.

To reduce this deformation and improve the life cycle of bucket the optimization of excavator bucket is done

1. Optimized Excavator Bucket:

This is carried out by increasing the thickness of the hinged plate because it is found that failure of bucket starts from the hinged plate. Then the CAD model of weld plate is created and is weld to the hinged plate due to this strength and force applied on hinged plate increases.

2. Also by changing the material properties the stresses are reduced with increase in life cycles. the existing bucket uses EN-8 & HARDO X-400 which having total deformation 2.677mm by changing the material to HARDOX-400



gives deformation 2.138mm which is considerably lower than existing one. And price is also affordable of this optimized material.

#### 4. Bucket Teeth

Analysis of Excavator Bucket Teeth Using FEM by NeerajChandrakar, Shadab Imam, Prakash, Arjun Kundu. Their paper addresses to the influence of Boron carbide and chromium variations on analysis of Bucket Teeth. FEM analysis are carried out and it is observed that best results are found by adding coating of Chromium and boron carbide of coating 2mm. the excavator bucket teeth which fail due to abrasive wear and impact load is protected against abrasive wear by using four different types of hard facing materials using manual metal arc welding process. The excavator bucket teeth have to bear heavy loads of materials like soil, rock and subjected to abrasion wear due to the abrasive nature of soil particles. So, its teeth got damaged due to abrasive wear and impact load. Hence they have used to analyze Excavator bucket teeth using finite element method (FEM). FEM is selected as the component size is complicated and the process is an all-position process, highly versatile and user friendly. The Result of Boron carbide and chromium steel having almost same result on Equivalent stress and deformation. The Result of the same is having higher Than High tensile steel by almost 0-1%. The Process of FEM is being used for Coating and without Coating of Excavator Bucket teeth

Analysis of Bucket Teeth of Backhoe Excavator Loader and its Weight Optimization by Bilal Pirmahamad Shaikh, Abid M. Mulla. Their paper mainly concentrates on backhoe excavator loader on wheel. For general backhoe loader digging forces find out by SEA J1179 standard. According SEA J1179 arm cylinder crowd force and bucket cylinder curl force calculated and maximum bucket cylinder curl force is used for critical analysis of excavator bucket tooth at maximum breakout force condition. For maximum digging force condition the evaluated digging force can be used as boundary condition and loading condition General purpose excavator bucket tooth like standard bolt on tooth and heavy duty fanggs digging tooth, long tooth, tiger tooth , twin tiger tooth and abrasion tooth are analyzed for their smallest series dimension and by

Observing their von misesstresses, total deformation patter necessary optimization are suggested and checked.

#### Methodology:

##### 1. Analysis of Teeth:

In static analysis one configuration of the mechanism has to be decided first for which the analysis is to be carried out. From all the configurations, the maximum breakout force condition is the most critical one as it produces the highest breakout force, and thus for this condition the force analysis is done, and will be used as a boundary condition for static FEA.

##### 2. Design of teeth:

Analysis is done for maximum force which can be generated by system/ backhoe link mechanism but in working condition system generate only required amount of force if excavation process required more force than system generate then system stops working.

##### 3. Modes of failure:

Stresses below yield strength obey Hook's law, so deformation in elastic limits. Sharp corner in load carrying area give rise stresses nearly 3-4 times as compare to surrounding.

##### 4. Forces calculations:

Bucket penetration into a material is achieved by the bucket curling force and arm crowd force. The rating of these digging forces is set by SAE J1179 standard "Surface Vehicle Standards - Hydraulic Excavator and Backhoe Digging Forces" (SAE International, 1990) also Maximum radial tooth force due to bucket cylinder is required to be calculated.

### III. CONCLUSION

1. By using light weight and high strength materials we can eliminate chances of structural failures of all above important elements of Backhoe assembly.
2. By proper consideration of length of dipper stick can eliminate trenching problems.
3. By removing material from the low stressed regions and re-designing the bucket link we optimizes the H-Link



design.

4. By considering different design parameters depending on locality we can optimize bucket design.
5. Analysis of tooth is done for maximum force which can be generated by backhoe Mechanism that should be considered while designing.

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7.512**

**ISSN** INTERNATIONAL  
STANDARD  
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